THE NERVOUS SYSTEM AND ELECTRIC CURRENTS

Volume 2

THE NERVOUS SYSTEM AND ELECTRIC CURRENTS

Volume 2

Proceedings of the Fourth Annual National Conference of the Neuroelectric Society, held in San Antonio, Texas, March 10-12, 1971

Edited by

Norman L. Wulfsohn

Associate Professor of Anesthesiology University of Texas Medical School at San Antonio San Antonio, Texas

and

Anthony Sances, Jr.

Professor and Chairman, Biomedical Engineering Marquette University and Medical College of Wisconsin Milwaukee, Wisconsin

PLENUM PRESS • NEW YORK-LONDON • 1971

Approved For Release 2002/05/17: CIA-RDP96-00787R000500200005-2

Antho Alan David Berna Jack

Library of Congress Catalog Card Number 70-114562

SBN 306-37172-3

© 1971 Plenum Press, New York A Division of Plenum Publishing Corporation 227 West 17th Street, New York, N.Y. 10011

United Kingdom edition published by Plenum Press, London A Division of Plenum Publishing Corporation, Ltd. Davis House (4th floor), 8 Scrubs Lane, Harlesden, NW10 6SE, England

All rights reserved

No part of this publication may be reproduced in any form without written permission from the publisher

Printed in the United States of America

All to:

THE NEURO-ELECTRIC SOCIETY

1971

CONFERENCE CHAIRMAN:

Norman L. Wulfsohn CONFERENCE SECRETARY: Edward F. Gelineau

University of Texas Medical School

San Antonio

OFFICERS

Anthony Sances, Jr., President, Marquette University Alan R. Kahn, Vice President, Medtronic Inc., Minneapolis, Minnesota David V. Reynolds, Vice President, University of Windsor Bernard Saltzberg, Vice President, Tulane University Jack J. Snyder, Secretary, Hoffman-La Roche, New Jersey

NATIONAL ADVISORY BOARD

Edgar J. Baldes Joseph J. Barboriak Robert O. Becker Carmine D. Clemente Donald F. Flickinger Lester A. Geddes Ernest O. Henschel Reginald A. Herin Raymond T. Kado Sanford J. Larson Irving Lutsky Simon E. Markovich

James A. Meyer James W. Prescott Donald H. Reigel Alfred W. Richardson Lawrence R. Rose Charles E. Short Kenneth A. Siegesmund Charles F. Stroebel Calvin C. Turbes Arthur S. Wilson Norman L. Wulfsohn

All enquiries for the Neuro-Electric Society should be addressed

Mr. Jack Snyder Senior Research Associate Department of Medical Research Hoffman-La Roche Inc. Nutley, New Jersey 07110

Approved For Kelease 2002/05/17 *** CIA-RDP96-00/67/R000500200005-2

PREFACE

This second volume of the "Nervous System and Electric Currents" represents the collected papers of the Proceedings of the fourth annual national conference, organised by the Neuro-Electric Society. It will be held at the Convention Center, San Antonio, Texas, March 10-12, 1971.

The interests of the Neuro-Electric Society focus upon the measurement and quantification of neuro-electric phenomena, neuro-stimulation and recording techniques and procedures, and the applications of biomedical engineering to the furthering of our understanding about neural-behavioral processes.

These research papers further explore the influence of electrical currents on the neurophysiological correlates of the nervous system. The "central" nervous system is still the main focus of research. The use of transcranially applied electric currents in the production of electro-sleep and electro-anesthesia is the important practical clinical aspect of these interesting researches. However, a new emphasis is now also beginning to be placed on the effects of these applied currents to the "peripheral" nervous system.

The Editors wish to thank the following sponsors: Office of Naval Research, Washington, D.C. (Grant No. NR 108-918); Medtronic Inc., Minneapolis, Minnesota; and Plenum Press, New York, New York. We also wish to thank for their cooperation the Association for the Advancement of Medical Instrumentation, Bethesda, Maryland, the Institute of Electrical and Electronic Engineers (Group of Engineering in Medicine and Biology), New York, New York, and the International Society for Electro-sleep and Electro-Anesthesia, Graz, Austria.

We would like to thank Mr. E. Gelineau and Mrs. Linda Peters for their untiring help in preparation of this Proceedings Book.

The Editors,

Norman L. Wulfsohn Anthony Sances, Jr.

March 1971

LIST OF CONTRIBUTORS

- Robert D. Allison, Chief, Cardiovascular Physiology, Scott and White Clinic, Temple Texas
- Maxim Asa, Director, Department of Physiology and Clinical Research, Monmouth Medical Center, Long Branch, New Jersey
- S. C. Ayivorh, Biophysics Research Unit, Faculty of Pharmacy, University of Science and Technology, Kumasi, Ghana
- L. E. Baker, Baylor College of Medicine, Houston, Texas
- Edmundo Baumann, Institute of Bio-Medical Electronics, Department of Physiology, University of Toronto, Division of Neurosurgery, Toronto General Hospital, Toronto, Canada
- D. Brittain, Baylor College of Medicine, Houston, Texas
- Joseph D. Bronzino, Worcester Foundation for Experimental Biology, Shrewsbury, Massachusetts
- Leo A. Bullara, Huntington Institute of Applied Medical Research, Pasadena, California
- Neil R. Burch, Head, Psychophysiology Division, Texas Research Institute of Mental Sciences, Texas Medical Center, Houston, Texas
- P. Cabler, Baylor College of Medicine, Houston, Texas
- Enrique J. A. Carregal, University of Southern California School of Medicine, Los Angeles, California
- Guillermo Chavez-Ibarra, Department de Investigacion Cientifica, Centro Medico Nacional, IMSS, Mexico, D. F.

LIST OF CONTRIBUTORS

Ν.

S.

Н

- M. E. Cherviakov, Laboratory of Experimental Physiology for Animal Resuscitation, Academy of Medical Sciences, First Moscow Medical Institute, Moscow, USSR
- J. K. Cywinski, Department of Anesthesia, Massachusetts General Hospital, Boston, Massachusetts
- José M. R. Delgado, Department of Psychiatry, Yale University School of Medicine, New Haven, Connecticut
- Jerry S. Driessner, University of Texas Medical School, San Antonio, Texas
- Daniel A. Driscoll, Union College, Schenectady, New York
- P. W. Droll, Research Scientist, Ames Research Center, NASA, Moffett Field, California
- Allan H. Frey, Technical Director, Randomline, Incorporated, Willow Grove, Pennsylvania
- Harry G. Friedman, Research Program Manager, Medtronic Incorporated, Minneapolis, Minnesota
- L. A. Geddes, Baylor College of Medicine, Houston, Texas
- E. Gelineau, Department of Anesthesiology, University of Texas Medical School, San Antonio, Texas
- Oldrich Grünner, Balneological Research Institute, Working Center Spa, Jesenik-Graefenberg, Czechoslovakia
- H. L. Gurvich, Laboratory of Experimental Physiology for Animal Resuscitation, Academy of Medical Sciences, First Moscow Medical Institute, Moscow, USSR
- Susan Halter, Department of Anatomy, Queen's University, Kingston, Ontario, Canada
- Warren Harding, Orthopedic Resident, University of California at Los Angeles Medical Center, Los Angeles, California
- L. Hause, Departments of Pathology and Neurosurgery, Medical College of Wisconsin, Milwaukee, Wisconsin
- Norman Hoffman, Departments of Neurosurgery and Chemistry, Medical College of Wisconsin and Marquette University, Milwaukee Wisconsin
- Michael Hoshiko, Department of Pathology and Audiology, Southern Illinois University, Carbondale, Illinois

OF CONTRIBUTORS

gy for Animal t Moscow

ts General

iversity

l, San

•

⊃rk

, NASA,

orated,

as

of Texas

king Center

or Animal
Moscow

y, Kingston,

fornia at

dical College

ry, Medical waukee

, Southern

LIT OF CONTRIBUTORS

- W. Heu, Systems Analyst, Department of Psychiatry of the University of Missouri School of Medicine at the Missouri Institute of Psychiatry, St. Louis, Missouri
- I. M. Itil, Professor and Associate Chairman, Department of Psychiatry of the University of Missouri School of Medicine at the Missouri Institute of Psychiatry, St. Louis, Missouri
- F. J. Iufer, Research Scientist, Ames Research Center, NASA, Moffett Field, California
- K. P. Kaverina, Laboratory of Experimental Physiology for Animal Resuscitation, Academy of Medical Sciences, First Moscow Medical Institute, Moscow, USSR
- A. S. Khalafalla, Systems and Research Center, Honeywell Incorporated, St. Paul, Minnesota
- Judith M. Kilby, Faculty of Science, University of Science and Technology, Kumasi, Ghana
- G. A. Kitzmann, NRC-NASA Resident Research Associate, Ames Research Center, Moffett Field, California
- J. J. Konikoff, Environmental Sciences Laboratory, General Electric Company, Philadelphia, Pennsylvania
- Jan Kryspin, Institute of Bio-Medical Electronics, Department of Physiology, University of Toronto, Division of Neurosurgery, Toronto General Hospital, Toronto, Canada
- A. C. K. Kutty, Palat House, Panniyankara Calicut, Kerala, India
- M. N. Kuzin, Laboratory of Experimental Physiology for Animal Resuscitation, Academy of Medical Sciences, First Moscow Medical Institute, Moscow, USSR
- S. J. Larson, Department of Neurosurgery, Medical College of Wisconsin, Milwaukee, Wisconsin
- Benjamin Lesin, Orthopedic Research Resident, Rancho Los Amigos Hospital, Downey, California
- Aime Limoge, L'ecole Nationale de Chirurgie-Dentaire de Paris, Montrouge, France
- H. M. Liventsev, Laboratory of Experimental Physiology for Animal Resuscitation, Academy of Medical Sciences, First Moscow Medical Institute, Moscow, USSR

- Y. Maass, Bioengineer, COMM/ADP Laboratory, H. Q., USAECOM, Fort Monmouth, New Jersey
- John Marasa, Scientific Programmer Analyst, Department of Psychiatry of the University of Missouri School of Medicine at the Missouri Institute of Psychiatry, St. Louis, Missouri
- Simon E. Markovich, Clinical Associate Professor of Neurology, University of Miami, School of Medicine, Coral Gables, Florida
- Richard E. McKenzie, University of Texas Medical School, San Antonio, Texas
- Donald R. McNeal, Director of Neuromuscular Engineering, Rancho Los Amigos Hospital, Downey, California
- Jose Medina-Jimenez, Somepsic, Mexico, D. F.
- V. D. Minh, Pulmonary Research Fellow University of California, San Diego School of Medicine, University Hospital of San Diego County, San Diego, California
- L. H. Montgomery, Assistant Professor, Vanderbilt University School of Medicine, Nashville, Tennessee
- Vert Mooney, Chief, Amputee and Problem Fracture Service, Rancho Los Amigos Hospital, Downey, California
- Kenneth M. Moser, Associate Professor of Medicine, Director, Pulmonary Division, University of California, San Diego School of Medicine, San Diego, California
- B. A. Negovskii, Laboratory of Experimental Physiology for Animal Resuscitation, Academy of Medical Sciences, First Moscow Medical Institute, Moscow, USSR
- C. H. Nute, Computer Specialist, Department of Psychiatry of the University of Missouri School of Medicine at the Missouri Institute of Psychiatry, St. Louis, Missouri
- E. Otis, Department of Orthopedics, Monmouth Medical Center, Long Branch, New Jersey
- Robert Pearson, Department of Neurophysiology, Rancho Los Amigos Hospital, Downey, California

UST OF C

D. P.

Robert

Donald N

M

A. W.

R.J.

C. Rom

Saul I

M. Rul

A. Sa

Rene :

о. н.

Herma

s. I

John

EN OF CONTRIBUTORS

COM, Fort

CONTRIBUTORS

∍f Medicine

- Missouri

San

es,

Rancho

Cornia, E San

ity School

Rancho

ego

or,

r Animal ∶cow

of the

r, Long

amigos

- D. P. Photiades, Biophysics Research Unit, Faculty of Pharmacy, University of Science and Technology, Kumasi, Ghana
- Medicine, Pasadena, California School of Medicine, Pasadena, California
- Medical College of Wisconsin and Marquette University, Milwaukee, Wisconsin
- A. W. Richardson, Department of Physiology, Southern Illinois University, Carbondale, Illinois
- R. J. Riggs, Faculty of Science, University of Science and , Technology, Kumasi, Ghana
- C. Romero-Sierra, Department of Anatomy, Queen's University, Kingston, Ontario, Canada
- Saul H. Rosenthal, Associate Professor, Department of Psychiatry, University of Texas Medical School, San Antonio, Texas
- M. Rubin, Department of Physiology, Southern Illinois University, Carbondale, Illinois
- A. Sances, Jr., Department of Biomedical Engineering, Medical College of Wisconsin, Milwaukee, Wisconsin
- Rene Sanchez-Sinencio, Instituto Mexicano de Electrosueno y Electroanesthesia, Mexico, D. F.
- O. H. Schmitt, Department of Biophysics, University of Minnesota, Minnesota
- Herman P. Schwan, Electromedical Division, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pennsylvania
- S. I. Schwartz, Department of Surgical Research, University of Rochester School of Medicine and Dentistry, Rochester, New York
- John H. Seipel, Director, Neurology Department, Maryland State Psychiatric Research Center, Baltimore, Maryland; Chief of Neurological Research, Friends of Psychiatric Research, Inc.; and Clinical Instructor in Neurology, Georgetown University Hospital, Washington, D. C.

- D. Shapiro, Computer Scientist, Department of Psychiatry of the University of Missouri School of Medicine at the Missouri Institute of Psychiatry, St. Louis, Missouri
- C. Norman Shealy, Chief of Neurosurgery, Gundersen Clinic, Associate Clinical Professor of Neurological Surgery, University of Minnesota. Assistant Clinical Professor of Neurological Surgery, University of Wisconsin Medical School, Madison, Wisconsin
- C. Hunter Shelden, University of Southern California School of Medicine, Pasadena, California
- K. A. Siegesmund, Department of Anatomy, Medical College of Wisconsin, Milwaukee, Wisconsin
- Roger C. Simon, Department of Physiology, Southern Illinois University, Carbondale, Illinois
- Hans-Guenther Stadelmayr-Maiyores, Munich, West Germany
- K. Steven Staneff, San Angelo, Texas
- D. B. Stratton, Department of Physiology, Southern Illinois University, Carbondale, Illinois
- B. J. Tabak, Laboratory of Experimental Physiology for Animal Resuscitation, Academy of Medical Sciences, First Moscow Medical Institute, Moscow, USSR
- J. A. Tanner, Control Systems Laboratory, National Research Council, Ottawa, Canada
- R. L. Testerman, Department of Surgical Research, University of Rochester School of Medicine and Dentistry, Rochester, New York
- H. C. Tien, Michigan Institute of Psychosynthesis, Lansing, Michigan
- W. J. Wajszczuk, Section of Cardiology, V. A. Hospital, Wilmington, Delaware
- Edgar L. Watkins, General Dynamics, Pomona, California
- E. R. Winkler, Department of Physiology, Southern Illinois University, Carbondale, Illinois

LIST OF

N. L.

Willa

D. E.

V. D.

Е. Ј.

of the

ONTRIBUTORS

, r of ! School,

ol of

э£

ĺ.S

na I

ty of

mington,

- Wulfsohn, Department of Anesthesiology, University of Texas Medical School, San Antonio, Texas
- *: !!ard G. Yergler, Department of Orthopedic Surgery, Indiana University School of Medicine, Indianapolis, Indiana
- D. E. Yorde, Department of Anatomy, Medical College of Wisconsin, Milwaukee, Wisconsin
- V. D. Zhukovskii, Laboratory of Experimental Physiology for Animal Resuscitation, Academy of Medical Sciences, First Moscow Medical Institute, Moscow, USSR
- E. J. Zuperku, Medical College of Wisconsin, Marquette University, Milwaukee, Wisconsin

- D. Shapiro, Computer Scientist, Department of Psychiatry of the University of Missouri School of Medicine at the Missouri Institute of Psychiatry, St. Louis, Missouri
- C. Norman Shealy, Chief of Neurosurgery, Gundersen Clinic, Associate Clinical Professor of Neurological Surgery, University of Minnesota. Assistant Clinical Professor of Neurological Surgery, University of Wisconsin Medical School, Madison, Wisconsin
- C. Hunter Shelden, University of Southern California School of Medicine, Pasadena, California
- K. A. Siegesmund, Department of Anatomy, Medical College of Wisconsin, Milwaukee, Wisconsin
- Roger C. Simon, Department of Physiology, Southern Illinois University, Carbondale, Illinois

Hans-Guenther Stadelmayr-Maiyores, Munich, West Germany

- K. Steven Staneff, San Angelo, Texas
- D. B. Stratton, Department of Physiology, Southern Illinois University, Carbondale, Illinois
- B. J. Tabak, Laboratory of Experimental Physiology for Animal Resuscitation, Academy of Medical Sciences, First Moscow Medical Institute, Moscow, USSR
- J. A. Tanner, Control Systems Laboratory, National Research Council, Ottawa, Canada
- R. L. Testerman, Department of Surgical Research, University of Rochester School of Medicine and Dentistry, Rochester, New
- H. C. Tien, Michigan Institute of Psychosynthesis, Lansing, Michigan
- W. J. Wajszczuk, Section of Cardiology, V. A. Hospital, Wilmington,

- Edgar L. Watkins, General Dynamics, Pomona, California
- E. R. Winkler, Department of Physiology, Southern Illinois University, Carbondale, Illinois

LIST OF

 $Will_i$

V. D.

E. J.

CONTENTS

SECTION 1

ELECTRO-NEUROPHYSIOLOGY I	١.
Radio Communication with the Brain	3
On the Penetration of UHF Energy Through the Head A. H. Frey	11
Evaluation of Electrostimulation of Hearing by Evoked Potentials	15
Mechanisms of Electricity Conduction in Brain and Kidney Studied by Impedance Measurements and Chrono- potentiometric Polarography J. Kryspin and E. Baumann	19
Bioelectric Potential Changes in Bone During Immobilization . J. J. Konikoff	25
SECTION 2	
ELECTRO-NEUROPHYSIOLOGY II	
A Neural Feedback Circuit Associated with Sleep-Waking J. D. Bronzino	29
Autonomic Nervous Control of the Intrinsic Cardiac Pacemaker and Its Electronic Analogue Simulator J. K. Cywinski, W. J. Wajszczuk, and A. C. K. Kutty	35
A Theoretical Analysis of RF Lesions Using Spherical Electrodes	47

Approved For Release 2002/05/17 : CIA-RDP96-00787R000500200005-2

xviii CONTENTS SECTION 3 ELECTRO-NEUROPHYSIOLOGY III Klect Period Analysis of the Clinical Electroencephalogram . R. March Spectral Analysis of the EEG on the PDP-12 C. H. Nute, J. Marasa, and T. M. Itil W. 57 Period Analysis of the EEG on the PDP-12 Thres D. Shapiro, W. Hsu, and T. M. Itil ٧. Psychosynthesis: A TV-Cybernetic Hologram Model Develo-R. Ε. SECTION 4 The C: NEUROPHYSIOLOGICAL EFFECTS OF ELECTRIC CURRENTS C. The Effects of DC Current on Synaptic Endings . . . D. E. Yorde, K. A. Siegesmund, A. Sances, Jr., and Peripl Μ. Ε. The Effect of Magneto-Inductive Energy on Reaction Time Performance D. P. Photiades, R. J. Riggs, S. C. Ayivorh, and Effect of an Electromagnetic Field on the Sciatic Nerve "What C. Romero-Sierra, S. Halter, and J. A. Tanner R. A Theoretical Analysis of Neuronal Biogenerated Respon G. A. Kitzmann, P. W. Droll, and E. J. Iufer L. 87 Polarization Changes Induced in the Pyramidal Cell and Selec: Other Neural Elements by Externally Applied L. Hause, A. Sances, Jr., and S. Larson Safet . L. Standa SECTION 5 PERIPHERAL NERVE AND SPINAL CORD STIMULATION S. The Design of Implantable Peripheral Nerve Stimulators . . . Limit Η.

Approved For Release 2002/05/17 : CIA-RDP96-00787R000500200005-2

CONT	ENTS	CONTENTS	xix
		Electrical Stimulation of the Rabbit's Aortic Nerve and the Dog's Carotid Sinus Nerve: A Parameter Study . R. L. Testerman and S. I. Schwartz	101
• • •	55	Muscle Response to Internal Stimulation of the Peroneal Nerve in Paraplegic Patients	107
	57		
	59	Threshold Distributions of Phrenic Nerve Motor Fibers: A Factor in Smooth Electrophrenic Respiration V. D. Minh and K. M. Moser	109
• • •	61	Development of an Implantable Telestimulator	111
ς		The Current Status of Dorsal Column Stimulation for Relief of Pain	113
• • •	69	Peripheral Nerve Regeneration by Electrical Stimulation M. Asa, H. Friedman, W. Harding, B. Lesin, V. Mooney, E. Otis, R. Pearson, and Y. Maass	115
• • •	75	SECTION 6	
t _e		SAFETY FACTORS IN BIOELECTRIC IMPEDANCE MEASUREMENTS	
• • • .	81	"What's Important in Safe Medical Electronics Instrumentation"	119
	87	Response to Passage of Sinusoidal Current Through the Body . L. A. Geddes, L. E. Baker, P. Cabler, and D. Brittain	121
		Selective Differential Electrocardiographic Leads A. S. Khalafalla and O. H. Schmitt	131
• • •	93	Safety Factors in Bioelectric Impedance Measurements L. H. Montgomery	139
		Standardization Committee on Bioelectrical Impedance Measurements	143
ION	of the control of the	Limit Current Density of Safe Tissue Exposure	145
• • •	99	H. P. Schwan	

	(CONTENTS
Problems in the Clinical Interpretation of the Impedance Plethysmogram and Rheoencephalogram J. H. Seipel	•	. 147
SECTION 7		
ELECTROSLEEP		
A Qualitative Description of the Electrosleep Experience S. H. Rosenthal	• •	. 153
Electrosleep, Hypnosis and Auditory Evoked Potentials to Words, a New Psychological Approach G. Chavez-Ibarra, R. Sanchez-Sinencio, and J. Medina-Jimenez	o •	157
Electrosleep: Some Interesting Case Reports K. S. Staneff	o •	159
Some Psychophysiologic Effects of Electrical Transcranial Stimulation (Electrosleep) R. E. McKenzie, S. H. Rosenthal, and J. S. Driessner		163
Electrosleep Enhanced by Intravenous Lidocaine N. L. Wulfsohn and E. Gelineau		169
Electronic Noise in Cerebral Electrotherapy	•	175
Wireless Electrostimulation of the Brain (ESB)	۰	181
å.		
SECTION 8		
ELECTRO-ANESTHESIA		
Obstetric Electro-Analgesia	•	189
Electro-Anesthesia for Electrical Cardio-Version B. A. Negovskii, M. N. Kuzin, H. M. Liventsev, B. J. Tabak, H. L. Gurvich, V. D. Zhukovskii, M. E. Cherviakov, and K. P. Kaverina	a	195
Rectangular Electroanesthesia Currents and the Primary Visual Pathways		197

CONT

Elect

Me ch.

Effe

Surg D

Inde

E . A

Approved For Release 2002/05/17: CIA-RDP96-00787R000500200005-2

CONTENTS	CONTENTS						xxi	
m . 147	D	evice kler, D. 1		ctable Batter	• • • • •	• • •	205	
	Mechanisms o A. Limoge	f Electro-	·Analgesia ,		0 p 6 0 0	o 5 •	209	
e 153	Effect of Electroanesthesia Upon Circulating Serotonin 217 D. H. Reigel, A. Sances, Jr., S. J. Larson, and N. Hoffman							
157	Surgical Expo D. H. Reig	eriences w gel, A. Sa	ith Electronces, Jr.,	anesthesia . and S. J. La	rson		219	
	Index		a • • • •	0 0 0 0 •	• • & • •	· · ·	223	
159					,			
163					•			
169	v							
175			`,					
181			ŧ	i.				
				•		*		
							٠,	
189								
195	·		1					
un-Albanian ingganaga			:. •					
197								